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Proximal and Time-Varying Effects of Cigarette, Alcohol, Marijuana and other Hard Drug Use on Adolescent Dating Aggression

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Abstract

Although numerous studies have established a link between substance use and adult partner violence, little research has examined the relationship during adolescence and most extant research has not examined multiple substance use types. The current study used hierarchical growth modeling to simultaneously examine proximal (between-person) and time-varying (within-person) relations between cigarette, alcohol, marijuana and hard drug use and physical dating aggression across grades 8 through 12 while controlling for demographic covariates and shared risk factors. Proximal effects of marijuana use on dating aggression were found for girls and proximal effects of hard drug use on dating aggression were found for boys. Time-varying effects were found for alcohol for both boys and girls and for hard drug use for boys only. Overall, findings suggest that alcohol, marijuana and hard drug use predict whether and when adolescents engage in dating aggression and should be targeted by prevention interventions.

Adolescent dating aggression (DA) is a prevalent national problem (Centers for Disease Control and Prevention [CDC], 2012) that can result in devastating consequences including injury, depression, and suicidal ideation (Exner-Cortens, Exkenrode, & Rothman, 2013; O'leary, Slep, Avery-Leaf, & Cascardi, 2008). Research generally suggests that substance use is an important risk factor associated with adolescent (e.g., Epstein-Ngo et al. 2013; Reyes, Foshee, Bauer, & Ennett, 2011; Rivera-Rivera, Allen-Leigh, Rodriguez-Ortega, Chavez-Ayala, & Lazcano-Ponce, 2007; Rothman, Johnson, Azrael, Hall & Wienberg, 2010; Temple, Shorey, Fite, Stuart, & Le, 2013) and adult partner violence (Moore et al., 2008; Shorey, Stuart, & Cornelius, 2011; Smith, Homish, Leonard, & Cornelius, 2012). However, key methodological limitations of previous research constrain interpretation and generalizability of these findings. In particular, most studies of associations between substance use and DA, have focused exclusively on a single type of substance use (e.g. alcohol use; Reyes et al. 2011), combined substance use indicators into a global construct (e.g., Schnurr & Lohman, 2008), or used analytic approaches that do not account for correlations among different substance use behaviors (e.g., Rothman et al., 2010). In all

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these cases, examination of the unique effects of multiple different substance use behaviors in relation to dating or partner aggression is precluded. More generally, little longitudinal research has examined relations between substance use and DA over the course of adolescence, a critical developmental period when patterns of substance use and relationship conflict may initiate and become established.

The few studies that have examined unique associations among multiple distinct substance use behaviors and adolescent DA suggest that associations may depend on substance use type and may differ for boys and girls, although findings are inconsistent. For example, using daily calendar-based analyses, Epstein-Ngo et al. (2013) found that alcohol, but not marijuana or sedative/opiate use, was associated with higher rates of severe DA in a sample of high risk urban girls. Using cross-sectional data, Rivera-Rivera et al. (2007) found an association between “illegal” drug use (marijuana and other types of illicit substance use combined) and DA among both boys and girls, whereas alcohol use was associated with DA only among girls. Using longitudinal data, Temple et al. (2013) found that hard drug and alcohol use each uniquely predicted DA among boys and girls, but marijuana use did not. In contrast, also using longitudinal data, Foshee, Reyes, & Ennett (2010) found that marijuana use predicted onset of DA among girls, but neither cigarette nor alcohol use was associated with DA onset among either boys or girls.

Taken together, these findings suggest that there may be heterogeneity in the relationshisp between different substance use types and DA that may not be detected in studies that group different substance use behaviors into a global construct and/or fail to account for potential gender differences in relationships. Furthermore, some research suggests that associations between substance use and DA may vary over time and/or depend on whether one is examining whether substance use predicts *who* is at risk for DA (between-person effects) and/or whether substance use predicts *when* DA risk is elevated (within-person effects; Hussong, Huang, Curran, Chassin, & Zucker, 2010; Reyes et al. 2011). Very few studies of relations between substance use and DA have used analytic approaches designed to disentangle these different effects or examine variability in associations over time, possibly contributing to the inconsistent findings described above.

Theoretical linkages

Developmental models suggest several potential explanations for the linkage between substance use and DA. As one explanation, high levels of substance use across adolescence may interfere with the development of communication and interpersonal skills needed to form healthy relationships and may index a life-course persistent pattern of antisocial behavior that manifests as DA (Hussong, Curran, Moffitt, Caspi, & Carrig, 2004; Reyes et al., 2011). Moreover, through peer selection and socialization processes, adolescents who repeatedly engage in substance use tend to become embedded in peer contexts characterized by low levels of behavioral constraint and high levels of deviant behavior (Aikins, Simons, & Prinstein,, 2010; Dishion, Veronneau, & Myers, 2010). In turn, deviant peer affiliation may increase risk of dating abuse by making it less likely that the peer network would constrain abusive behavior and/or by increasing the likelihood that romantic partnerships form between teens with behavior problems. In addition to such persistent effects over the course of adolescence, at any given time, elevated substance use may increase an individual’s risk for DA directly, through psychopharmacological effects that disinhibit aggression, and/or indirectly, by contributing to relationship conflict that, in turn, leads to abuse (Klosterman & Fals-Stewart, 2006; Shorey et al., 2011).

The explanations outlined above suggest two types of over-time effects of substance use on levels of DA: proximal (between-person) effects and time-varying (within-person) effects.

Proximal (between-person) effects index whether adolescents who report higher average levels of substance use during a given developmental period in turn report higher levels of DA during that same period. Proximal effects thus focus on *who* is at risk for DA during adolescence, with the hypothesis that those who report higher compared with lower average substance use across the developmental period will be at greater risk (Hussong et al., 2010). Proximal effects are implied by theories suggesting that repeated substance use during adolescence may interfere with teens' capacities to establish and maintain healthy relationships (Klosterman & Fals-Stewart, 2006), enmesh teens in a toxic peer environment (Dishion et al., 2010) that may be conducive to dating abuse, and/or serve as a marker that identifies teens following a life-course persistent trajectory of involvement in aggressive behavior (Moffit 1993; Hussong et al., 2004).

Time-varying (within-person) effects of substance use index whether teens report increased (or decreased) dating abuse, over their usual baseline, at those time-points when they report increased (or decreased) substance use. Time-varying effects focus on *when* a given adolescent might engage in DA, with the expectation that adolescents are at greater risk *at those times* when they are engaging in higher than average levels of substance use (Hussong et al., 2010). Time-varying effects are implied by theories that suggest a direct psychopharmacological effect of substance use on DA, as well as by theories that suggest that elevated substance use at a given time-point may put acute stress on the romantic relationship that contributes to conflict and abuse (Klosterman & Fals-Stewart, 2006; Shorey et al., 2011).

The Current Study

Proximal and time-varying effects are conceptually distinct and, as such, disaggregating and examining these effects simultaneously can provide unique insights into the etiology of the relationship between substance use and DA by providing a better understanding of whether, for whom, and when different types of substance use are related DA. To this end, the current longitudinal study simultaneously examined both the proximal and time-varying effects of cigarette, heavy alcohol, marijuana, and other illicit ("hard") drug use on trajectories of physical DA across grades 8 through 12. We test the general hypothesis that substance use exerts risk for adolescent dating abuse via both proximal and time-varying effects. This hypothesis is examined for each substance controlling for the other substances and the effects of psychosocial covariates including emotional distress, family conflict, peer aggression, and dating abuse victimization; these psychosocial covariates were included because both theory and empirical evidence suggests that each of these variables is associated with both substance use and DA and thus could potentially drive spurious associations between the two behaviors (Andrews, Foster, Capaldi, & Hops, 2000; Bray, Adams, Getz, & Baer, 2001; Ehrensaft et al. 2003; Smith et al. 2012; Wolfe, Wekerle, Scott, Straatman, & Grasley, 2004) . In addition, because previous research suggests that relations between substance use and DA may vary over time and differ for males and females, we examine potential sex and grade-level differences in associations; inconsistencies in previous research precluded making specific hypotheses related to these interactions.

Method

Participants

Data are from a longitudinal study of adolescent risk behavior that was conducted in two non-metropolitan counties in North Carolina. Adolescents in the 6th, 7th, and 8th grades attending public schools in the two counties completed self-administered questionnaires in school in Spring of 2002 and then again for a total of seven waves of data collection until they were in grades 10, 11 and 12 (Ennett et al., 2006; Foshee et al., 2011). Dating violence

was assessed beginning when participants were in the 8th, 9th and 10th grades. As such, the current study uses four waves of data starting when participants were in the 8th, 9th and 10th grades (referred to as wave one; W1) and ending when participants were in the 10th, ll[th], and 12th grades (referred to as wave four; W4). Six-month time intervals separated the first three waves and a one-year interval separated W3 and W4.

At W1, all students attending the 8th, 9th and 10th grades able to complete the survey in English and not in special education programs or out of school due to long-term suspension were eligible. Parents had the opportunity to refuse consent for their child's participation by returning a written form or calling a toll-free number. Assent was obtained from teens whose parents did not refuse consent. The Institutional Review Board at the sponsoring university approved the study protocols.

Of the 3343 students eligible for participation at W1, 2636 (79%) completed a questionnaire. Approximately 6% of parents refused consent, 6% of adolescents declined to participate and 8% were absent on the days when data were collected. Analyses excluded students who were missing data on race (n=30), gender (n=20), dating status across all waves (n=68), and/or DA across all waves (n=74), yielding a final analytic sample size of 2455. Nearly all students participated in at least two waves of data collection (n=2299, 94%), with 78% participating in 3 or more waves (n=1920).

Approximately half of the analysis sample was male (47%); the self-reported race/ethnicity distribution was 45% White, 47% Black, and 8% other race/ethnicity; and 40% of participants reported that the highest education obtained by either parent at baseline was high school or less. At W1, the prevalence of substance use in the past three months was 27% for cigarette use, 18% for heavy alcohol use, 21% for marijuana use, and 4% for hard drug use (see Table 1 for prevalence rates by grade and sex). These prevalence rates are comparable to those reported by Monitoring the Future, a national study of adolescent drug use in the United States (Johnston, O'Malley, Bachman, & Schulenberg, 2009).

Measures—Measures included physical dating aggression, the four substance use variables, demographic covariates and four psychosocial covariates measuring shared risk factors. Demographic covariates were treated as time-stable. For each psychosocial covariate and substance use variable a time-varying indicator (TVI) was created based on adolescents self-reports at each wave. The TVIs were then averaged across waves (within person) to create proximal indicators (PIs).

Physical dating aggression was defined as the use of physical force with the potential for causing harm against a dating partner and was measured at all waves using a short version of the Safe Dates Physical Perpetration Scale (Foshee, et al., 1996). Adolescents were asked, "During the past 3 months, how many times did you do each of the following things to someone you were dating or on a date with?

Don't count it if you did it in self-defense or play." Six behavioral items (e.g., pushed or shoved them) were listed and response categories ranged from none (0) to ten or more times (4). Scores were summed to create a physical DA measure at each wave (average Cronbach's α =.93). Students who were not involved in dating at a given wave were given a score of zero.

All substance use measures used a past three-month reference period. *Cigarette smoking* was assessed by one item assessing the frequency (number of days) of smoking; response options ranged from zero days (0) to 20 days or more (5). We assessed *heavy alcohol use* using four items asking adolescents how many times they had: 3 or 4 drinks in a row, 5 or more drinks

in a row, gotten drunk or very high from drinking alcohol, or been hung over. Response categories ranged from none (0) to ten or more times (4). Item scores were averaged to create a composite scale of heavy alcohol use at each wave (average Cronbach's α =.95). *Marijuana use* was assessed by one item asking respondents how often they had engaged in marijuana use; response categories were the same as for alcohol use. *Hard drug use* was assessed by asking respondents how often they had engaged in "other hard drug use (cocaine, LSD, heroin, Ecstasy, or other)"; due to low prevalence (see Table 1) answer options were dichotomized at each wave (any use/no use in the past three months).

Covariates. Grade level was centered at grade 8 and sex was coded such that male=1 and female=0. *Race* was coded by dummy variables indicating if the adolescent self-reported as Black or Other Race/ethnicity (White is the reference category). *Parent education* ranged from less than high school (0) to graduate school or more (5) and was coded at each wave as the highest level of education attained by either caregiver and then averaged across waves. *Peer aggression* was defined and assessed using the same six behavioral items used to assess physical dating aggression except with peers as the reference. Adolescents were specifically asked to exclude acts perpetrated against a date. Scores were averaged to create a composite scale of adolescent physical aggression against peers at each wave (average Cronbach's α =.91). *Family conflict* was defined as the degree to which conflictual interactions characterize the social climate of the family (Moos, Insel, & Humphrey, 1974) and was assessed by three items from Bloom's (1985) self-report measure of family functioning (e.g., we fight a lot in our family). Item scores were averaged to create a measure of family conflict at each wave (average Cronbach's α =.87). *Emotional distress* was defined as experiencing unpleasant or negative feelings and emotions and was measured using three subscales assessing anger (Zuckerman & Lubin, 1985), anxiety (Reynolds & Richmond, 1979) and depression (Angold, Costello, & Messer, 1995) in the past three months. We averaged item scores to create a subscale score for each construct (average α =. 89 for anger, α =.89 for anxiety, α = .92 for depression) and then standardized and averaged the subscale scores to create a composite measure of emotional distress. *Dating abuse victimization* was defined as experiencing any form of physical, sexual, or psychological violence within a dating relationship and was measured by a series of items assessing how many times someone the adolescent was dating or on a date with had perpetrated an act of physical (six items; e.g., pushed or shoved), sexual (two items; e.g., forced sex) or psychological (four items; e.g, insulted in front of others) aggression against them. Adolescents who reported any past three month victimization were scored as a "1" and adolescents who reported no victimization were scored as a "0."

Analyses—Analyses proceeded in several phases. First, data were reorganized such that the grade-level of the respondent was used as the primary metric of time rather than wave of assessment. This allowed for trajectories of DA to be continuously modeled across grades eight through twelve. Second, we addressed the issue of missing data in our time-invariant and time-varying covariates through multiple imputation (Rubin, 1987) using SAS PROC MI (SAS Institute, 2003). Third, following the recommendations of Raudenbush and Bryk (2002, p. 183) for disaggregating within- and between-person effects, time-varying indicators (including both the psychosocial covariates and substance use indicators) were person-mean centered and included in the model as level one within-person predictors of DA. The reports of these covariates averaged over the repeated assessments (proximal indicators) were grand-mean centered and included in the model as the level two between-person proximal effects.

Fourth, preliminary analyses were conducted to determine the functional form and error structure of the trajectory model that best fit our repeated measures of DA. Replicating previous analyses using this same sample (Reyes, et al., 2011), the best fitting model was a

quadratic model with heteroscedastic errors and a random intercept. Finally, to test our hypotheses, we estimated a series of conditional multilevel models. We first examined the proximal and time-varying associations between each substance use type and the repeated measures of DA controlling only for the psychosocial and demographic covariates. This was done to get a sense of the association between each substance use type and DA without controlling for the other types of substance use. Second, we estimated a model that included all of the substance use types as well as control variables but did not include interactions with sex or grade-level. This allowed us to assess whether associations with DA were maintained for a particular substance use when other substance use types were controlled (Model 1). Next, to examine interactions with sex and grade-level, we estimated a "full" model that included the demographic controls, the time-varying (TVI) and proximal indicators (PI) of the psychosocial covariates and the four substance use types, as well as all possible two- and three-way interaction terms with sex and grade. To produce a reduced model, we then systematically tested sets of higher (Grade x Sex x TVI; Grade x Sex x PI) and lower-order (Grade x TVI; Grade x PVI; Sex x TVI; Sex x PI) interactions using multivariate Wald tests. Sets of interactions that did not significantly contribute to the model according to the multivariate Wald test (α=.05) were dropped. Within sets of interactions that did contribute significantly to the model, we examined the individual t-tests of the parameter estimates for each interaction term and retained only those interactions that were statistically significant (at $p<.05$) in the final reduced model (Model 2).

Results

In preliminary models that examined each substance use type separately we found significant positive proximal and time-varying associations between each target substance use type and the repeated measures of dating aggression even after controlling for demographic and psychosocial covariates ($p<.01$ for all associations, results not shown) . Table 2 presents the results from the multivariate substance use model (Model 1) that included the main proximal and time-varying effects of all four types of substance use as well as controls. Proximal and time-varying effects for cigarette use were attenuated to non-significance as were the proximal effects of heavy alcohol use and the time-varying effects of marijuana use. Proximal effects for marijuana and hard drug use and time-varying effects for heavy alcohol and hard drug use maintained statistical significance.

Interactions with sex and grade-level

All multivariate Wald tests of sets of interactions between substance use and sex and grade-level are presented in Table 3. Significant individual interactions were found between sex and hard drug use (proximal and time-varying effects), marijuana use (proximal effects), and dating abuse victimization (proximal and time-varying effects). In addition, significant interactions were found between grade-level and heavy alcohol use and dating abuse victimization (time-varying effects). These interactions were retained in the final reduced model (Model 2), which is presented in Table 2. Interactions were probed by producing model-estimated simple slopes denoting the effect of the focal substance use variable on the outcome at different levels of the moderator variable (i.e., for boys and girls and across different grade-levels); these findings are reported below for each interaction term.

Proximal effects

In the final model (Model 2), proximal or between-person effects were not found for either cigarette or alcohol use. Proximal effects were found for marijuana and drug use; however ,these effects differed by sex. Specifically, marijuana use had a proximal effect on DA for girls ($b=0.07$, $p<.001$), but not for boys ($b=-0.001$, $p=.94$), whereas hard drug use had a proximal effect on DA for boys ($b=0.08$, $p<.001$), but not for girls ($b=.02$, $p=0.25$).

Time-varying effects

In the final model, a time-varying or within-person effect for heavy alcohol use was associated with increased risk for DA for both boys and girls; however this effect varied by grade-level and by sex. Specifically, the time-varying effect of alcohol use was found to decrease over time, such that effects were strong in early adolescence but diminished over time. In addition, across all grade-levels, elevated hard drug use was found to increase DA among boys (b=0.42, p<.001), but not girls (b=.10, p=.16).

Psychosocial covariate effects

Although not the focus of the current study, we note that proximal and time-varying effects of family conflict, peer aggression, and dating abuse victimization (but not emotional distress) were significantly associated with increased DA (see Table 2). That is, family conflict, peer aggression and dating abuse victimization, were found to predict both *who* is at risk for DA (i.e., adolescents who reported higher levels of family conflict, victimization, and/or peer aggression across grades 8 through 12), as well as *when* adolescents were at risk for increased DA (i.e., at the same time that family conflict, peer aggression and/or dating abuse victimization was elevated). These effects were unique from the effects of the substance use indicators. Results further suggest that the effects of dating abuse victimization were stronger for girls than for boys (victimization x sex interaction), and that time-varying effects diminished over time for both boys and girls (victimization x grade interaction). Taken together, these findings suggest that adolescents, and in particular girls who experience higher levels of dating abuse victimization across adolescence, also tend to engage in higher levels of DA compared to teens who report lower levels of victimization. In addition, within each grade-level, victimization is significantly correlated with DA, with stronger associations in early as compared to late adolescence and for girls compared to boys.

Discussion

The current study extends previous research documenting an association between substance use and partner violence by providing a more nuanced picture of whether, for whom, and when substance use is related to physical dating aggression during adolescence. Notably, we found that heavy alcohol, marijuana, and other hard drug use, but not cigarette use, are uniquely associated with increased risk for physical DA during adolescence even after controlling for demographic and psychosocial covariates as well as the other substance use types. The specific nature of these associations varied, however, by substance use type, effect type (proximal vs. time-varying), sex, and grade-level. Specifically, we found that risk for DA increased during times when either heavy alcohol (boys and girls) or hard drug (boys only) use was elevated (time-varying effects), possibly reflecting the psychopharmacological effects of these substances on DA. Further, higher overall levels of hard drug (boys only) and marijuana (girls only) use during the assessment period were associated with higher levels DA across all grades (proximal effects); these findings are consistent with the notion that boys who engage in elevated hard drug use and girls who engage in elevated marijuana use across adolescence may be enmeshed in environments that put them at risk for life-course persistent involvement in DA. Notably, results suggest that relations between marijuana and hard drug use and DA were moderated by sex, consistent with research suggesting that the etiology, progression and consequences of substance use may differ for boys and girls (Brady & Randall, 1999). We elaborate on study findings for each substance use type.

Cigarette Use

Significant proximal and time-varying associations were found between cigarette use and DA in preliminary models that controlled for psychosocial covariates but did not control for the other substance use types. However, with control for the other substance use types, associations between cigarette use and DA were no longer significant. This pattern of effects is consistent with the work of adult partner violence researchers that suggests the importance of controlling for co-occurrence of substance use types when examining the linkages between substance use and DA (Feingold, Kerr, & Capaldi, 2008). While cigarette use may be a marker for DA risk, the association appears to be driven by the correlation between cigarette and other types of substance use.

Heavy Alcohol Use

Consistent with previous research using this sample (Reyes et al. 2011), there was a significant positive time-varying association between heavy alcohol use and DA among both boys and girls that tended to diminish over time. The current study extends previous research by establishing a unique time-varying effect of heavy alcohol use after controlling for other substance use types. Results are consistent with daily-level research (e.g., Rothman et al. 2012; Epstein-Ngo et al. 2013) that has found that DA is more likely to occur on drinking than on non-drinking days. As one explanation, heavy alcohol use may increase risk for DA by negatively impacting cognitive function and distorting perceptual cues, thereby disinhibiting aggressive behavior. As noted by Reyes et al. (2011), the pattern of diminishing associations over time may be attributed to the fact that, over time, cognitive (e.g., inhibitory control) and social-contextual (e.g., normative beliefs) constraints against the use of dating aggression tend to strengthen and may buffer the effect of alcohol use on dating aggression among older teens.

Marijuana

Results suggest that girls, but not boys, who reported higher levels of involvement in marijuana use across the study period also reported higher levels of DA (proximal effect). While research examining sex differences in the correlates and consequences of marijuana use is limited (Schepis, et al. 2011; Tu, Ratner, & Johnson, 2008; Farhat, Simons-Morton, & Luk, 2011), one potential explanation is that, for girls, but not for boys, marijuana use may be associated with mental health problems (Tu et al., 2008) and/or index a generalized propensity for antisocial and aggressive behavior (Farhat et al. 2011; Pederson, Mastekaasa, & Wichstrom, 2001) that increase risk for involvement in DA. However, previous studies examining linkages between sex, marijuana use and violent behavior provide inconsistent findings (Moore et al., 2008; Moore & Stuart, 2005; Smith et al., 2012). As such we view our findings with caution; further research is needed to understand whether and how marijuana use and gender may work synergistically to confer risk for DA.

It is also notable that we did not find time-varying effects of marijuana use for either boys or girls; this finding does not support a direct psychopharmacological link between marijuana use and DA. Results are consistent with previous research that has found no relationship between daily marijuana use and dating/partner aggression (Epstein-Ngo et al. 2013; Fals-Stewart, Golden, & Shumacher, 2003) as well as with studies examining other types of aggressive behavior that have found that aggressive acts are more often related to self-reported acute alcohol use than acute marijuana use (White, Fite, Pardini, Mun, & Loeber, 2013; White & Hansell, 1998). Laboratory studies have also generally found null or inconsistent findings for relations between marijuana use and aggressive behavior, prompting researchers to question the validity of the psychopharmacological model and suggest the importance of examining distal and proximal factors that may moderate associations (for a review, see Moore & Stuart, 2005).

Hard Drug Use

Both proximal and time-varying effects for hard drug use were found for boys, but not for girls. As noted above, repeated hard drug use during adolescence may be a marker indexing a life-course persistent pattern of antisocial behavior that manifests as DA among boys. In addition, involvement in hard drug use at a given time point may increase risk for DA through the same psychopharmacological mechanisms described above for heavy alcohol use. However, it is unclear why proximal and time-varying linkages between hard drug use and DA were found for boys but not girls. One possible explanation comes from research by Kulis and colleagues (Kulis, Marsiglia, & Hecht, 2002) that suggests that dominant masculinity may be associated with hard drug use among boys but not girls. We speculate that, compared to non-drug-users, boys who engage in hard drug use may have a greater propensity for engaging in DA because they hold masculinity beliefs that condone the use of violence against women as a means of exerting power and control (dominance); these beliefs may work synergistically with intoxication effects (which lower inhibitions against the use of aggressive behavior) to increase risk for DA among boys, but not girls. Our results are not consistent, however, with other studies that have found associations between hard drug use and dating/partner aggression among both males and females (Moore et al., 2008; Temple et al., 2013). As such, findings should be viewed with caution.

Limitations

There are several limitations to this study. First, although our hypotheses suggest a direction of influence from substance to DA, our study was not designed to determine causality or temporal ordering between the two behaviors. Second, we did not distinguish among patterns of experimental versus chronic substance use nor did we assess patterns of polysubstance use in relation to DA. Polysubstance use has been associated with adult partner violence (Feingold et al., 2008) and future research should make this area of inquiry a priority. Third, data were self-report and thus social desirability bias may have influenced survey responses. Fourth, the sample was drawn from predominantly rural areas; findings thus may not be generalizable to urban/suburban contexts. In addition, at W1approximately 8% of eligible participants were not assessed because they were absent from school when data were collected. This could potentially affect generalizability in that frequently absent students have been found to engage in more risk behaviors, including substance use, than those who are rarely absent (Bovet, Viswanathan, Faeh, & Warren, 2006). Fifth, we used statistical procedures (multivariate Wald tests) designed to reduce Type I error due to multiple testing of interaction terms; however it's possible that insufficient power resulted in Type II error, a failure to detect moderation effects. Finally, in general, the magnitude of the effects found in this study was relatively small. This is not surprising given that analysis were conservative in testing multiple proximal and time-varying effects jointly while simultaneously controlling for several covariates (Hussong et al., 2010). Further, small effects are common when investigating longitudinal associations using within-individual change models (White et al., 2013).

Conclusion

To our knowledge this is the first study to simultaneously examine proximal and time-varying effects of different types of adolescent substance use behaviors to determine both who is at risk overall for DA and whether risk is elevated during time points when substance use is elevated. As such, it informs understanding of the complex relationships between substance use and adolescent DA. Results overall confirm the importance of heavy alcohol, marijuana, and hard drug use as unique risk factors associated with increased risk for DA and suggest that evaluations of adolescent substance use prevention programs should assess potential effects on dating abuse outcomes. In order to further inform intervention

development, future research should build on the current study to replicate findings and explore the casual mechanisms that account for between and within-person relations between substance use and DA, as well as potential moderators of these relations. Our findings suggest there may be multiple distinct pathways linking different substance use behaviors to DA and that these mechanisms may differ for boys and girls. A better understanding of these linkages could contribute to determining whether and how interventions designed to prevent or reduce substance-use related DA should be tailored to address substance- and/or sex-specific risk/protective factors.

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Table 1

Prevalence of heavy alcohol, cigarette, marijuana and hard drug use in the past three months by grade-level and sex

	Grade														
	8			9			10			11			12		
	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F
Cigarette Use	18	16	21	33	32	35	31	31	32	33	36	30	24	26	23
Heavy Alcohol Use	13	12	9	21	21	18	24	24	21	25	27	23	27	30	25
Marijuana Use	10	12	14	19	19	23	22	23	25	26	32	21	23	29	18
Hard Drug Use	3	3	2	5	4	5	5	6	4	5	8	2	4	7	2

Note: T=total; M=male; F=female.

Table 2

Proximal and time-varying associations between substance use and physical dating aggression across grades 8 through 12

	Model 1 b (se)	Model 2 b (se)
Level 2 (proximal effects)		
Substance use type		
Cigarette	−0.02 (.01)	−0.02 (.01)
Alcohol	0.02 (.02)	0.03 (.02)
Marijuana	0.03 (.01)*	0.07 (.02)***
Hard Drug Use	0.05 (.02)**	0.02 (.02)
Marijuana × Sex	--	−0.07 (.02)**
Hard Drug Use × Sex	--	0.05 (.02)*
Psychosocial covariate		
Family Conflict	0.02 (.01)*	0.02 (.01)^
Emotional Distress	−0.01 (.01)	−0.01 (.01)
Peer Aggression	0.10 (.01)***	0.10 (.01)***
Victimization	0.14 (.01)***	0.16 (.01)***
Victimization × Sex	--	'−0.07 (.02)***
Level 1 (time varying effects)		
Substance use type		
Cigarette	0.0003 (.01)	−0.001 (.01)
Alcohol	0.05 (.01)***	0.11 (.02)***
Marijuana	0.01 (.01)	0.01 (.01)
Hard Drug Use	0.28 (.04)***	0.10(0.07)
Hard Drug Use × Sex	--	0.32 (0.08)***
Alcohol × Grade	--	−0.03 (.01)***
Psychosocial covariate		
Family Conflict	0.02 (.01)*	0.02 (.01)*
Emotional Distress	0.01 (.01)	0.01 (.01)
Peer Aggression	0.17 (.01)***	0.17 (.01)***
Victimization	0.18 (.02)***	0.28 (.04)***
Victimization × Sex	--	−0.09 (.03)**
Victimization × Grade	--	'−0.03 (.01)*

Note: Models control for grade-level, sex, race and parent education.

Table 3

Multivariate Wald tests of sets of two- and three-way interactions between proximal and time-varying indicators of substance use, sex, and grade-level

Interaction set	Test statistic	*p*
Sex × Grade × PI; Sex × Grade2 × PI	F(16/3048)=0.31	.99
Grade × PI; Grade2 × PI	F(16/1959)=1.51	.09
Sex × Grade × TVI	F(8/1597)=1.01	.43
Grade × TVI	F(8/1219)=2.82	.004
Sex × TVI	F(8/1483)=3.11	.002
Sex × PI	F(8/1681)=4.66	<.001

Note: PI=proximal indicators; TVI=time-varying indicators. PI and TVI included in each interaction set included four substance use variables (cigarette, heavy alcohol, marijuana, and hard drug use) and four psychosocial covariates (family conflict, emotional distress, peer aggression, and dating abuse victimization).